COST OPTIMIZATION AND EFFECT OF ACO PARAMETERS ON OPTIMIZED COST OF THE WIRELESS NETWORK

Nishtha Gupta
Electronics and Communication, ABES Engineering College, Noida (India)

ABSTRACT

Wireless is increasing day by day in the revolution of information technology. To formulate a design of wireless access network, by optimizing the objective function with the help of various set of constraints like total cost, data rate enhancement, throughput etc. The biggest challenge is to deal with optimizing problem. This paper focuses on optimizing or reducing the cost of wireless networks by improving the performance of the network i.e. maximizing throughput, minimizing end to end delay and jitter. The goal is to implement such an ACO algorithm that optimizes the cost by improving the performance of the network and how the ACO parameters effects optimized cost.

Keywords- ***ACO, Quality of Service, Wireless Network***

I. INTRODUCTION

In the previous papers various algorithms are proposed to optimized the cost of the wireless network by considering different set of constrains [1, 2, 4]. Wireless network consist of a large number of mobile nodes with the help of which communication can be done. Complexity increases with increase in mobile nodes. In networking and computer science, the traffic handling term known as quality of service (*QoS*) which refers to resource control mechanisms rather than the service quality which can be achieved. With the help of Quality of service priority can be assigned to various applications, users, or data flows, or to assure a level of performance to a data flow. There are many QOS metrics and those metrics are divided into two parts additive and concave. Throughput is the concave metrics i.e. non additive metrics whereas end to end delay and jitter are the additive metrics. Finding the best path i.e. the shortest path between the sources to destination is a difficult problem and to deal with additive and concave metrics optimization technique is used. In this paper, we propose an algorithm to minimized the cost using QOS parameters as a set of constraints and effect of ACO parameters on the optimized cost.

II. METHODOLOGY

Ant colony optimization is the technique which has been implemented for solving various optimization problems with best results. Ants don't use any direct communication they use indirect communication for solution process i.e. stigmergy [3]. This property is used to improve the cost of the network.

2.1 Problem Formulation

A simple network is considered in which objects are referred as nodes and connection between these nodes are vertices. Let N be the number of nodes (N_1, N_2, N_n) and M number of connections. Let Cj is the optimized cost of wireless network. Now the packet should be reached from source to destination by finding the shortest path using ACO.

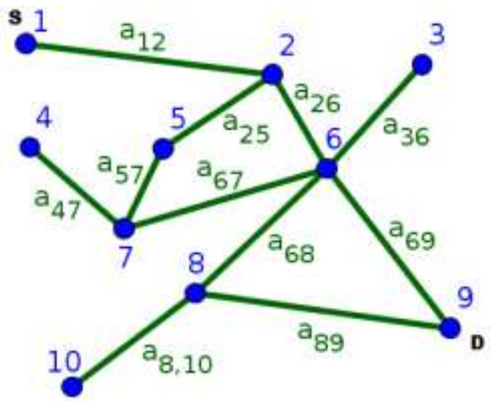

Fig 1. Simple Network

2.2 Ant Colony Optimization

The main source from where this ACO comes is the behavior that is displayed by species of ants in nature but the difficult task is the cooperation between the ants in the colony. To find out the shortest path Pheromone is used i.e. volatile chemical substance that is secreted by the ants in order to attract the other ants.

In this environment what happens ants start from their nest and move towards their food and laying down pheromone trails while going back towards their nest. If other ants find such a path, then they attracted towards the trail of pheromone and follow that path rather than travelling here and there. In the Ant Colony Optimization, problems are usually modeled in the form of graph or tree like structure. Let G (E, V) be a graph. Thus the components c_{34} are denoted by either the edges or the vertices of the graph. The objective is to find a shortest path between the source node V_3 and destination node V_4. Each edge of G maintains the value of chemical substance i.e. artificial pheromone concentration over the node and modified whenever an ant travel through it.

2.3 Solving Networks Using ACO Algorithm

The optimized cost is written as Cij which can be written in the form of matrix

$$(Cij)_{m\times n} = \begin{pmatrix} c_{10} & c_{11}\ldots\ldots c_{1m} \\ c_{20} & c_{21}\ldots\ldots c_{2m} \\ . & . \quad\quad . \\ . & . \quad\quad . \\ c_{n0} & c_{n1}\ldots\ldots c_{nm} \end{pmatrix} \quad (1)$$

A network can be defined as:

$$(yij)_{m\times n} = \begin{pmatrix} y_{10} & y_{11}.......y_{1m} \\ y_{20} & y_{21}.........y_{2m} \\ . & . \quad\quad . \\ . & . \quad\quad . \\ y_{n0} & y_{n1}.......y_{nm} \end{pmatrix} \quad (2)$$

where yij in (2) is defined as

yij = {1 if node 1 is connected to 2

0 if node is not connected

Algorithm proposed for optimizing the cost

2.4 Algorithm In Pseudo Code

– Initialize Trail
– Do While (Stopping Criteria Not Satisfied) – Cycle Loop
- Do Until (Each Ant Completes a route) – route Loop
- Local Trail Update
- End Do
- Analyze Routes
- Calculate routing metrics
- Global Trail Update
- Calculate Throughput, delay and jitter
- Determine the objective function

– End Do

2.5 Key Parameters

1. Trail intensity τ_{34} which indicates the intensity of the pheromone on the trail segment, (34)
2. Trail visibility is $\eta_{34} = 1/d_{34}$
3. The importance of intensity is given by α
4. The importance of visibility is given by β
5. The trail persistence or evaporation rate is given as ρ

2.6 Edge Selection

An ant is a simple communicating agent who communicates indirectly in the ant colony optimization algorithm. It iteratively constructs a solution to any type of problem whereas solution states are given by intermediate solutions and in this algorithm, each iteration ant moves from colony to food in order to complete the intermediate solution. Thus, each ant computes a set of feasible solutions. For ant n, the probability p of moving from one state to another i.e. from state 3 to state 4 depends on the combination of two values, the attractiveness η_{34} of the move, and the trail level τ_{34} of the move. The n^{th} ant moves from state 3 to state 4 with probability i.e. the probability of moving towards next node is given by

$$p_{34}^{n} = \frac{\tau_{34}^{\alpha} \times \eta_{34}^{\beta}}{\sum \tau_{34}^{\alpha} \times \eta_{34}^{\beta}} \qquad (3)$$

2.7 Pheromone Update

When all the ants have completed a solution i.e. reach towards their food from nest then the trails are updated by

$$\tau_{34}^{n} = (1- \rho)\, \tau_{34}^{k} + \Delta\, \tau_{34}^{k} \qquad (4)$$

Where τ_{34}^{n} is the amount of pheromone deposited for a state transition 34, ρ is the pheromone evaporation coefficient and $\Delta\tau_{34}^{k}$ is the amount of pheromone deposited.

2.8 Objective Function

The network cost D is defined as:

$$D=sum(C\times m_1)+(C\times m_2)+ (C\times m_3) \qquad (5)$$

where m_1, m_2 and m_3 are the performance metrics i.e. throughput, delay and jitter

D i.e. the objective function should be minimum whereas

m_1 is maximum and m_2 , m_3 are minimum.

III. SIMULATION MODEL

Cost is evaluated using QUALNET 5.0.2 and MATLAB 7.0.

Performance metrics throughput, average end to end delay and average jitter are used to evaluate the cost of the wireless network. Optimized parameters alpha, beta and rho are considered for finding the minimum cost.

3.1 SIMULATION PARAMETERS

For the experiment, we have considered different nodes of different difficulty levels. We have tried the different combinations of ACO parameters to get the best optimized result. The experiment was conducted on different problems at frequency 2.4GHz and data rate 2Mbps.

Table1: Beta =5 and rho = 0.65

Alpha	Delay and Jitter	Throughput	Cost
0.2	56.0022	1448.0023	804
0.5	56.0022	1384.0024	588
1	52.0022	1454.0023	414

Table 1 shows that at beta =5 and rho = 0.65 but with increase in alpha cost reduces by 27%.

Table2: Alpha =1 and rho = 0.65

Beta	Delay and Jitter	Throughput	Cost
1	52.0022	2048	418
2	48.0022	260	531
3	44.0022	1454	432
4	52	1310	701

Table 2 shows that at alpha =1 and rho = 0.65 but with increase in beta cost increases by 27%.

Table3: Beta =5 and alpha = 1

rho	Delay and Jitter	Throughput	Cost
0.1	40	1468	638
0.2	44	1404	241
0.3	46	1298	564
0.4	48	1978	256
0.5	44	890	533

Table 3 shows that at alpha =1 and beta = 5 but with increase in rho cost varies firstly it decreases and then increases by 27%

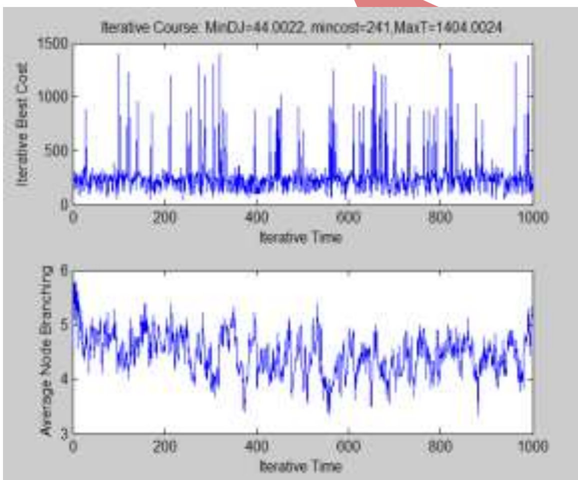

Fig 2: Iterative Best Cost And Average Node Branching At Alpha=1, Beta=5, Rho=0.2

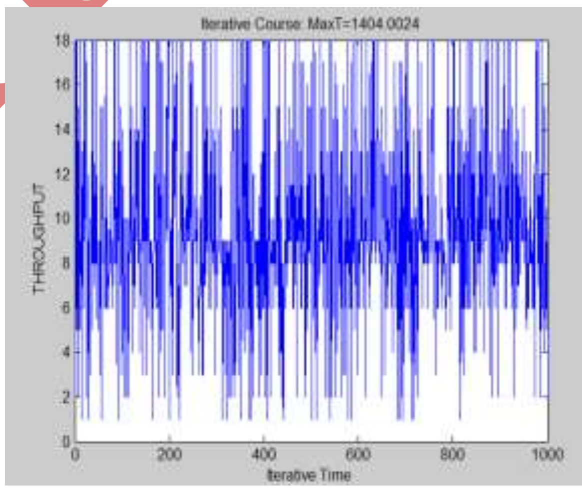

Fig 3: Throughput at Alpha=1, Beta=5, Rho=0.2

IV. CONCLUSION AND FUTURE SCOPE

From the above results it is concluded that wireless network is proposed to optimize three performance metrics i.e. throughput, end to end delay and jitter and determines the optimized cost of the network. This will optimized the overall system cost function and the cost function reduction is up to 27%. We get the optimized cost function at various combinations of ACO parameters like at alpha=2, beta= 2 and rho = 0.4 and so on but the best optimized cost function is at alpha=1, beta= 5 and rho= 0.2. Further it can be implemented using tabu search method and by considering more than three parameters.

REFERENCES

[1] Dac-Nhuong Le, Nhu Gia Nguyen, and Trong Vinh Le, A Novel PSO-Based Algorithm for the Optimal Location of Controllers in Wireless Networks, International Journal of Computer Science and Network Security, Vol.12 No.8,23--27 (2012).

[2] Rajeshwar Singh, "Performance Evaluation of ACO based on demand routing algorithm for mobile Adhoc network", IJEST, vol 3, No. 3, March 2011

[3] Singh Rajeshwar, D.K Singh and Lalan Kumar, "Ants Pheromone for Quality of Service provisioning in mobile Adhoc networks", International Journal of Electronics Engineering and Research, 2(1): 101-109, April 2010

[4] Al Huda Amri and et. al., "Scalability of manet routing protocols for heterogeneous and homogenous networks", Computers and Electrical Engineering, 2008 Problem using Ant Colony Algorithm

[5] R.Asokan, A.M. Natarajan and A. Nivetha, "A swarm-based distance vector routing to support multiple Quality of Service (QOS) metrics in mobile Adhoc Networks", Journal of computer science, 2007

[6] M. Dorigo, M. Birattari, and T. Stitzle, Ant Colony Optimization: Artificial Ants as a Computational Intelligence Technique", IEEE computational intelligence magazine, (2006).

[7] Gianni Di Caro, Frederick Ducatelle and Luca Maria Gambardella, "Swarm intelligence for routing in mobile Adhoc Networks", IEEE, 2005

[8] K. Kraimeche, B. Kraimeche, K. Chiang, Optimization of a wireless access network (2005).

[9] M. Dorigo, V. Maniezzo, and A. Colorni, Ant system: Optimization by a colony of cooperating agents, IEEE Trans. on System, MAN, and Cybernetics-Part B, vol. 26,29-41, (1996).